

Comparison of password checking libraries

Róbert Kolcún, rkolcun@redhat.com

1 Introduction

The main purpose of this document is to show how different password checking libraries react on leaked passwords(Rock You section) which we consider as weak passwords and on more complicated passwords(Secure passwords section) which we consider as good ones. All relevant files for this report can be downloaded here

<https://drive.google.com/open?id=1SiHHTKQTltov55oSr9gjcj26uLFAKev9>

Cracklib and PassWDQC library gives us output, OK or reason why the password was rejected.

Pwscore returns reason of rejection or password score, this score is in range from 0 to 100, passwords with a score higher than 39 are consider as OK.

Zxcvbn works same as Pwscore, but the score is in range from 0 to 4, so passwords with score 3 and 4 are OK.

For Passfault library is little bit more complicated, because the range of score is big, so we tried different values of threshold for this score (Table in document *Passfault_threshold.ods*), after that we choose threshold with value 100000000000, which gives us the best results.

2 RockYou

In the first place we take passwords from RockYou list, which users used at least 3 times. We consider these passwords, as passwords that should be rejected by libraries. In this list we have 1136143 unique passwords. This password list is in file *data.txt*.

2.1 Summary

In the tables below is summary for every password checking library, how many passwords were accepted/rejected and the most common reasons of rejection. Whole output is in file *LibrariesSummary*.

CrackLib accepted	CrackLib rejected	Top reasons of rejection
475095 (41.82%)	661048 (58.18%)	OK - 41.82% it is based on a dictionary word - 29.54% it is too simplistic/systematic - 11.87% it does not contain enough DIFFERENT characters - 10.92%

Table 1: CrackLib

PassWDQC accepted	PassWDQC rejected	Top reasons of rejection
3189 (0.28%)	1132954 (99.72%)	Bad passphrase (not enough different characters or classes for this length) - 66.44% Bad passphrase (too short) - 33.18% OK - 0.28% Bad passphrase (based on a dictionary word and not a passphrase) - 0.08%

Table 2: PassWDQC

Pwscore accepted	Pwscore rejection	Top reasons of rejection
93196 (8.2%)	1042947 (91.8%)	The password is shorter than 8 characters - 52.99% Low password score - 22.44% The password fails the dictionary check - it is based on a dictionary word - 12.72% OK - 8.2%

Table 3: Pwscore

Zxcvbn accepted	Zxcvbn rejection	Top reasons of rejection
75752 (6.67%)	1060391 (93.33%)	Add another word or two. Uncommon words are better. - 34.92% Common names and surnames are easy to guess. Add another word or two... ... Uncommon words are better. - 17.8% Dates are often easy to guess. Add another word or two. Uncommon words are better... ... Avoid dates and years that are associated with you. - 13.11%

Table 4: Zxcvbn

Passfault accepted	Passfault rejected	Top reasons of rejection
20057 (1.77%)	1116086 (98.23%)	'Match' in '10k-worst-passwords',... ... 'Random Characters with:[Numbers]' in '[Numbers]' - 6.27% 'Random Characters with:Numbers' in 'Numbers' - 5.99% 'Date Format' in 'null' - 5.36% 'Match' in 'usFirstNamesLongTail' - 3.32%

Table 5: Passfault

2.2 Top accepted passwords

The next tables shows top passwords or some interesting ones sorted by number of uses, that are accepted by password checking libraries. Whole output is in folder *LibrariesTopOkPasswords*.

Number of uses	Password	Password score by library
49952	iloveyou	-
15163	babygirl	-
13134	iloveu	-
1552	zxcvbn	-
1205	1q2w3e4r	-
1031	password123	-

Table 6: CrackLib

Number of uses	Password	Password score by library
154	j4**9c+p	-
119	#1hottie	-
85	Lets you update your FunNotes and more!	-
18	password1!	-
14	Password1!	-
9	Passw0rd!	-
7	123QWEasd	-

Table 7: PassWDQC

Number of uses	Password	Password score by library
3885	hellokitty	40.0
2871	qwertyuiop	46.0
2868	harrypotter	50.0
1031	password123	65.0
700	qwerty123	40.0
355	1q2w3e4r5t	46.0

Table 8: Pwscore

Number of uses	Password	Password score by library
1508	jesucristo	3.0
1292	diosesamor	3.0
1112	teamomucho	3.0
1047	sagitario	3.0
129	ilovemydog	3.0

Table 9: Zxcvbn

Number of uses	Password	Password score by library
541	i love you	119830608576.0
524	klapaucius	6643009985248.0
380	gwapoako	208827064576.0
52	q2w3e4r5	2821109907456.0
48	1a2s3d4f	2821109907456.0

Table 10: Passfault

2.3 One accepted, others rejected

The following tables shows passwords that are accepted by only one library(library name in table description) and rejected by others. So these passwords all libraries except one consider as weak.

Passwords are sorted by number of uses and only the top passwords are in the table. Whole output is in folder *AllRejectedOneAccepted*.

Number of uses	Password	Password score by library
49952	iloveyou	-
15163	babygirl	-
13134	iloveu	-
9610	fuckyou	-
7766	tinkerbelle	-

Table 11: Cracklib, Number of passwords: 343257

Number of uses	Password	Password score by library
119	#1hottie!	-
18	password1!	-
15	#1asshole	-
14	Password1!	-
13	3edc#EDC	-
11	123abc...	-

Table 12: PassWDQC, Number of passwords: 145

No passwords for Pwscore library.

Number of uses	Password	Password score by library
745	triskelion	3.0
604	margarida	3.0
306	143445254	3.0
220	kamikazee	3.0
205	lollypop1	3.0

Table 13: Zxcvbn, Number of passwords: 5236

Number of uses	Password	Password score by library
114	princ3ss	167958240768.0
76	pr1nc3ss	2821109907456.0
59	p.i.m.p	124246115028.0
58	abcdefghijklmnop	36916765946112.0
54	tay-tay	6722988818432.0

Table 14: Passfault, Number of passwords: 1626

2.4 Accepted by all libraries

These are top passwords that are accepted by all libraries (Cracklib, PassWDQC, Passfault, Pwscore, Zxcvbn).

Again the table is sorted by number of uses. Whole table is in file *AllAccepted*.

Number of uses	Password
91	<div><embed src=
85	Lets you update your FunNotes and more!
65	TEXT ONLY AD
37	l33tsupah4x0r
28	iydgTvmujl6f
26	ojkiyd0y'

Table 15: Number of password: 1794

3 Secure passwords

For next analysis we created a list of dictionary words, this list contain german, english, spanish, finland, italy, portugal words, india first & last popular names, spanish names, english first & last popular names and pet names. Words shorter than 4 characters were removed. This list contain 356791 words, list is in file *wordlist.trim.txt*.

After that we used several transformations to transform these passwords: Capitalize first letter, Capitalize last letter, Add two random digits as postfix or prefix, Apply advanced l33t table, Change random letter to random letter & Add random letter as postfix or prefix. So the password entropy increased around 20. We consider these passwords as secure, so the libraries should accept these passwords.

3.1 Summary

In the tables below is summary for every password checking library, how many passwords are accepted/rejected and the most common reasons of rejection.

Analysis output is in folder *LibrariesSummaryTransformedPass* in file *summary_LibrariesSummaryTransformedPass*.

We do not have data for Pwscore library, because checking this password list would take around 35 hours.

CrackLib accepted	CrackLib rejected	Reasons of rejection
355992 (99.78%)	799 (0.22%)	OK - 99.78%
		it is too simplistic/systematic - 0.14%
		it does not contain enough DIFFERENT characters - 0.08%

Table 16: CrackLib

PassWDQC accepted	PassWDQC rejected	Reasons of rejection
352790 (98.88%)	4001 (1.12%)	OK - 98.88%
		Bad passphrase (not enough different characters or classes for this length) - 1.09%
		Bad passphrase (based on a common sequence of characters and not a passphrase) - 0.02%

Table 17: PassWDQC

No data for Pwscore library.

Zxcvbn accepted	Zxcvbn rejected	Reasons of rejection
339804 (95.24%)	16987 (4.76%)	OK - 95.24% Add another word or two. Uncommon words are better. - 4.44% Dates are often easy to guess. Add another word or two... ... Uncommon words are better. Avoid dates and years that are associated with you. - 0.2%

Table 18: Zxcvbn

Passfault accepted	Passfault rejected	Reasons of rejection
351061 (98.39%)	5730 (1.61%)	OK - 98.39% 'Random Characters with:[Latin]' in '[Latin]', 'Random Characters with:Numbers' in 'Numbers' - 0.13% 'Random Characters with:Numbers' in 'Numbers', 'Random Characters with:[Latin]' in '[Latin]' - 0.12%

Table 19: Passfault

3.2 Top rejected passwords

The next table shows some examples of passwords that are rejected. Whole output for every password checking library is in folder *LibrariesSummaryTransformedPass*.

Password checking library	Number of passwords	Rejected password
Cracklib	799	000062q hi()L54 FH@ { {z01
PassWDQC	4001	y42p31L i02iiR30R n32&w60
Passfault	5730	c11v - ii / A s()~' ['3 2S98U Vei55 <A55d
Pwscore	0	-
Zxcvbn	16987	E![[j88B A ?7r26X T#()h58v

Table 20: Example of rejected passwords